ISSN XXXX XXXX © 2019 IJESC

Research Article Volume 9 Issue No.3

Outdoor Investigation of Monocrystalline PV Panel Incorporating Cooling Technique

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Abstract:
Temperature increment is one of the main challenges for solar concentrating photovoltaic systems which causes significant reduction in the cell efficiency and accelerates cell degradation. Due to high cell temperature distribution, current mismatching and hot spot occurs on the cell resulting in either permanent structure damage or reduction in efficiency. The aim of this project is to minimize the temperature, especially in hot arid regions and to increase the efficiency of solar panels. A cooling system has been developed based on peltier effect. This paper focuses on the improvement of the performance of small domestic use PV systems by keeping the temperature of the cells as low as possible.The temperature is sensed by the temperature sensor and when it reaches the allowable value cooling system is connected .So the cooling technique is one way to enhance the electrical efficiency of the PV panel.

Key words: Arduino UNO, sensors, LCD, ESP8266.

I. INTRODUCTION

Energy consumption is a grand controversial matter in the world today. Clean energy production using alternative sources such as solar energy is growing in attention amongst researchers due to its promises of lesser pollution contribution, negligible waste production and ease of implementation. Photovoltaic cells are commonly used today to transform the solar energy to electricity. However, the low efficiency of these cells and their high capital costs have had negative impacts on their popularity. Therefore, possible improvements to these cells' performance are widely appealing. The performance of these cells is highly dependent on cell temperature. Furthermore, it is clear that the cell temperature has a close tie with the ambient temperature. Accordingly, an innovative approach towards increasing these cells' efficiency is to utilize thermoelectric cooling in order to reduce the cells' temperature. Thermoelectric cooling can be described by the Peltier effect. This effect which occurs by heating or cooling one end of a circuit requires no operating fluids and therefore demands less maintenance and offers more reliability when compared to other cooling methods. Therefore, a combined TEC and PV design will be the subject of analyses in this paper. The combined TEC and PV system operates as a unit by converting the solar energy to electrical energy. The TEC module can either be supplied energy from an external source or utilize the energy converted by the PV module. In either case, the net power output remains the same. For this research, the latter was considered. Numerical analyses will be conducted based on this system to assess whether the proposed method will result in improvements to the performance of the PV cells. The efficiency of the combined system can be influenced by various design and operation parameters. An operation parameter which can affect the performance of these systems is the wind speed. This effect can demonstrate negative or positive feedbacks on the system based on the operating conditions. Furthermore, design parameters such as the fin area can play a role in these combined systems' output. Moreover, the TEC current can change the efficiency of the system based on the operating conditions, and an optimized amount can be calculated under certain circumstances.

Components Required
Solar panel, Peltierchip, DC brushless fan, DC pump, Temprature sensor

Block diagram of the proposed system

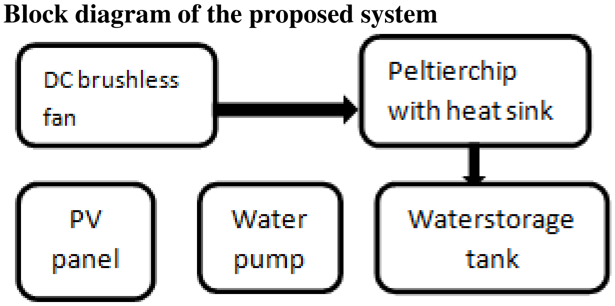

Figure.1. Monocrystalline PV panel

Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most modules are rigid, but semi-flexible ones based on thin-film cells are also available. The cells must be connected electrically in series, one to another. A PV junction box is attached to the back of the solar panel and it is its output interface..Externally, most of photovoltaic modules use MC4 connectors type to facilitate easy weatherproof connections to the rest of the system. Also, USB power interface can be used. Module electrical connections are made in series to achieve a desired output voltage or in parallel to provide a desired current capability (amperes). Some special solar PV modules include concentrators in which light is focused by lenses or mirrors onto smaller cells. This enables the use of cells with a high cost per unit area (such as gallium arsenide) in a cost-effective .Solar panels also use metal frames consisting of racking components, brackets, reflector shapes, and troughs to better support the panel structure.

DC brushless fan

Figure.2. DC brushless fan

Espressif's ESP8266EX delivers highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design and reliable performance in the Internet of Things industry. With the complete and self-contained Wi-Fi networking capabilities, ESP8266EX can perform either as a standalone application or as the slave to a host MCU. When ESP8266EX hosts the application, it promptly boots up from the flash. The integrated high speed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any microcontroller design as a Wi-Fi adaptor through SPI / SDIO or I2C / UART interfaces. ESP8266EX integrates antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules. The compact design minimizes the PCB size and requires minimal external circuitries.

Peltier Chip

Thermoelectric coolers operate by the Peltier effect (which also goes by the more general name thermoelectric effect). The device has two sides, and when a dc electric current flows through the device, it brings heat from one side to the other, so that one side gets cooler while the other gets hotter. The "hot" side is attached to a heat sink so that it remains at ambient temperature, while the cool side goes below room temperature. In some applications, multiple coolers can be cascaded together for lower temperature. Two unique semiconductors, one n-type and one p-type, are used because they need to have different electron densities. The semiconductors are placed thermally in parallel to each other and electrically in series and then joined with a thermally conducting plate on each side. When a voltage is applied to the free ends of the two semiconductors there is a flow of DC current across the junction of the semiconductors causing a temperature difference. The side with the cooling plate absorbs heat which is then moved to the other side of the device where the heat sink is. Thermoelectric Coolers, also abbreviated to TECs are typically connected side by side and sandwiched between two ceramic plates. The cooling ability of the total unit is then proportional to the number of TECs in it. Current semiconductors being explored for TEC applications are antimony and bismuth alloys. So far, they are the materials that have led to the largest efficiency TEC systems. This is because they have a combination of low thermal conductivity and high electrical conductivity. These two factors, when combined, increase the system's figure of merit (ZT), which is a measure of the system's efficiency. The equation for ZT can be found bellow, where alpha is the Seebeck coefficient. There are very few other materials that could be used for TEC applications since the relationship between thermal and electrical conductivity is usually a positive correlation. If these two values decrease or increase together, however, the overall effect is a net zero and the ZT value would remain too low for commercial applications. Despite it being such a new technology, there are many factors motivating further research on TEC including lower carbon emissions and ease of manufacturing. One of the most significant benefits of TEC systems is that they have no moving parts. This lack of mechanical wear increases the lifespan of the system..

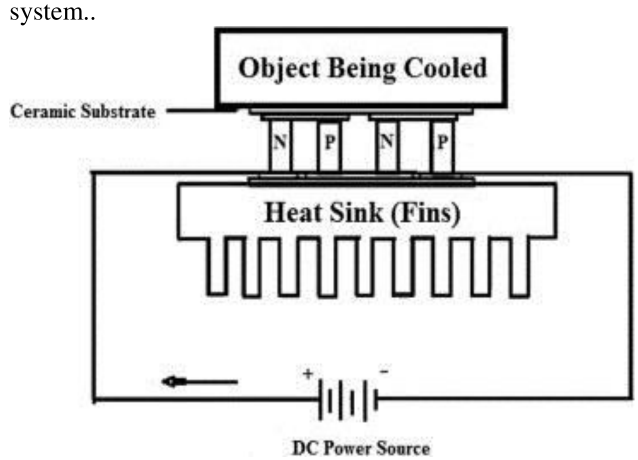

Figure.3. peltier fridge

Working

The PV panel used in this project is about 1.6 m2 and the yearly output should therefore be somewhere around 240 kWh. Compared to the energy output of the climate panel this corresponds to a COP value for the panel of around 5. This is agreeable with the result presented in table 7. As stated earlier this value is probably a bit too optimistic, but since this product is not yet fully developed and further testing is needed it could be used as a theoretical benchmark for futurethe initial prototype there is great room for improvements. When used along with commercial heating systems they pay-back time is short enough to make the climate panel a worthy investment. It needs to be remembered, however, that it cannot be used as a replacement of the existing heating system but simply as a complement.

II. CONCLUSION

The purpose of this project has been to investigate the possibility of designing a solar driven air-toair heat pump by connecting Peltier elements to a PV panel, and evaluate its potential. The results showed that, as the prototype is designed now, it is possible to save up to 1 300 kWh a year if adding the panel to an existing heating system. This corresponds to 9% of the heating and 5% of the total energy need for a “normal” Swedish house. Depending on the system used along with the pay-back time of the panel is between 3-10 years, which is in the range of other heating systems. It was proven that the output is larger in heating mode than cooling mode, which correlates with the need of a Swedish house. Two paths have been outlined for further development of the project. The first is to use the panel as a complement to an existing heating system..

Future scope
In order to increase the efficiency of solar panel here we use .

III. REFERENCES

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